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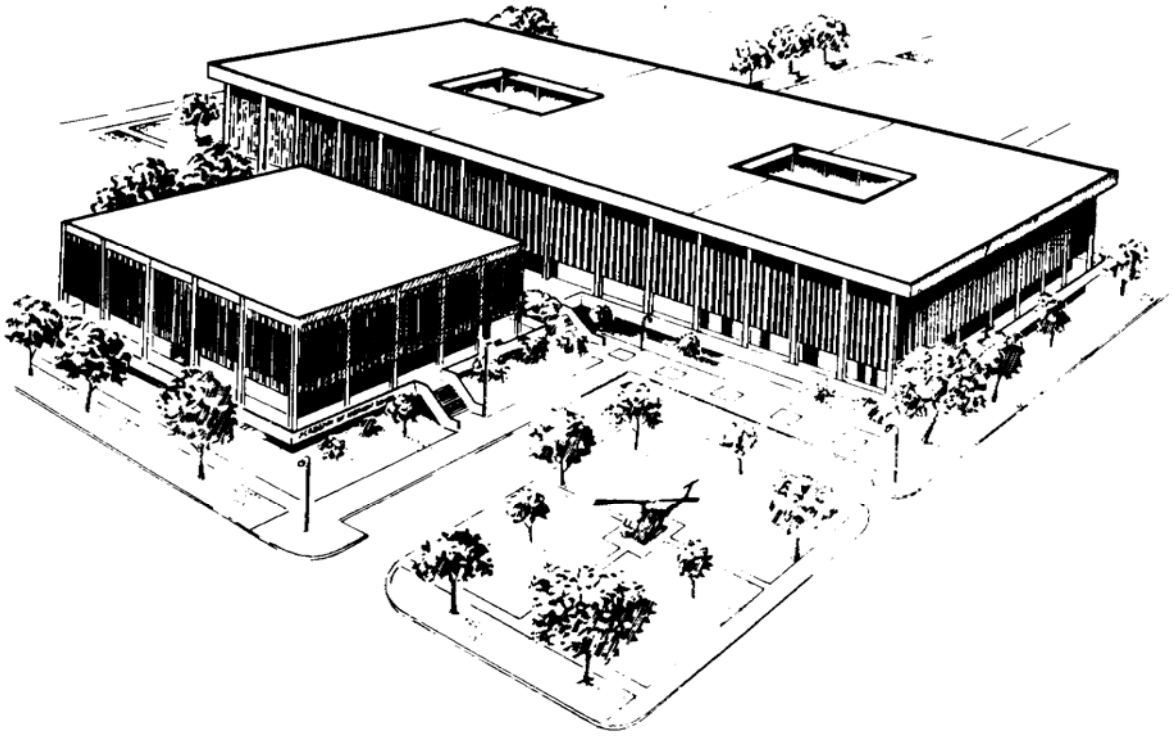
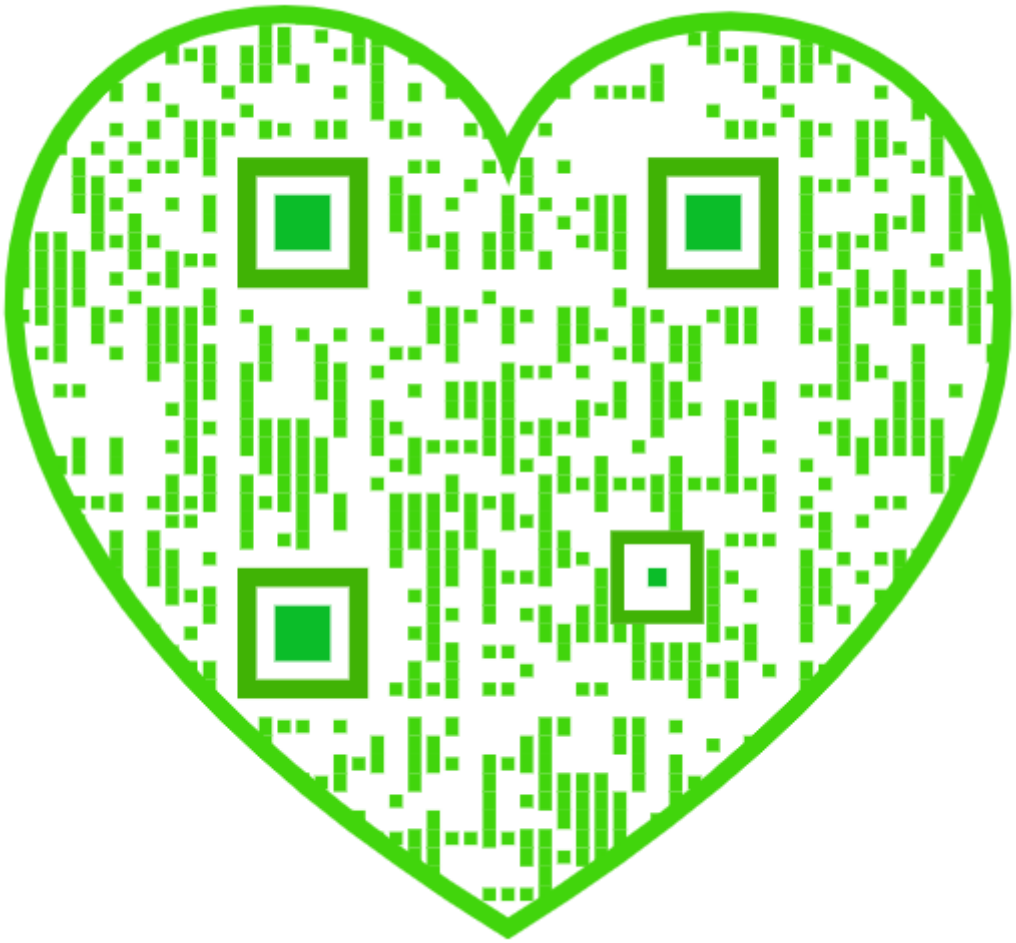


THE ENDOCRINE SYSTEM

SUBCOURSE MD0583 EDITION 100



DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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Students who desire credit hours for this correspondence subcourse must meet eligibility requirements and must enroll in the subcourse. Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application and then follow the on screen instructions.

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CLARIFICATION OF TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" 'are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0583

THE ENDOCRINE SYSTEM

INTRODUCTION

Two systems, the nervous system and the endocrine system, work together to regulate and integrate the processes of the body. The activities of these systems operate like an interlocking supersystem. Some parts of the nervous system stimulate the release of hormones while some parts of the endocrine system stimulate nerve impulses. In this subcourse, you will study the endocrine system, its anatomy, physiology, diseases, and disorders. A particular disease, diabetes mellitus, will also be studied. Do your best to achieve the objective of this subcourse. As a result, you will be better able to perform functions of your medical MOS.

Subcourse Components:

The subcourse instructional material consists of seven lessons as follows:

Lesson 1, Anatomy and Physiology of the Endocrine System.
Lesson 2, Diseases and Disorders of the Endocrine System.
Lesson 3, Diabetes Mellitus.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 8 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1	Anatomy and Physiology of the Endocrine System.
LESSON ASSIGNMENT	Paragraphs 1-1 through 1-9.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

1-1. Define endocrine gland, hormone, target, and action.

1-2. Identify the composition and activities of hormones.

1-3. Identify the chief hormone(s) secreted by the glands of the endocrine system.

1-4. Identify the target and primary actions of the major hormones secreted by the endocrine system.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

ANATOMY AND PHYSIOLOGY OF THE ENDOCRINE SYSTEM

1-1. GENERAL

The endocrine system is one of two major systems which control the body's activities. The endocrine system is composed of glands which secrete substances called hormones into the bloodstream. These hormones act as chemical messengers and float in the bloodstream to the body's organs, the target of the particular hormone. At the target, the hormone causes some action. The hormone either turns on a biochemical reaction or turns off a biochemical reaction.

a. **The Endocrine System and the Nervous System.** The endocrine system works with the nervous system to regulate and integrate the processes of the body such as growth, development, reproduction, response to stress, and change of food into energy and body tissue. The two systems work together like a giant super system. Some parts of the nervous system stimulate or prevent the release of hormones. Some hormones can stimulate or prevent the flow of nerve impulses.

b. **Composition and Activities of Hormones.** Hormones are composed of proteins, amino acids, or steroids. Although hormones affect many of the body's activities, hormone actions can be categorized into four broad areas:

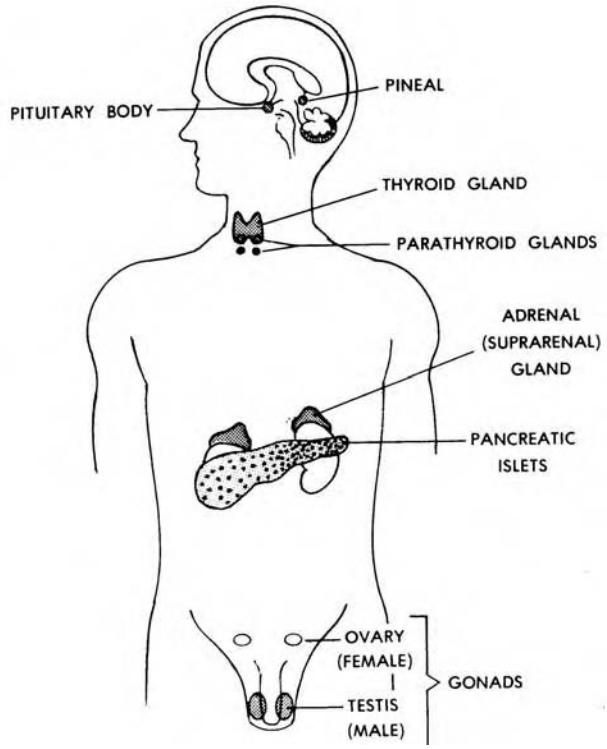

Figure 1-1. General location of major endocrine glands.

(1) Internal environment control. Hormones help control the body's internal environment by regulating the chemical composition and volume of the body's fluids and tissues.

(2) Environmental condition adjustments. Hormones help the body adjust to changes in the environment. Thanks to various hormones, the body can cope with emergency demands such as infection, trauma, emotional stress, dehydration, starvation, hemorrhage, and temperature extremes.

(3) Growth and development.
Hormones are instrumental in regulating the growth and development of the body.

(4) Reproduction. Hormones are very important in the basic process of reproduction. Various hormones play a significant part in fertilization, nourishment of the embryo and fetus, delivery, and nourishment of the newborn.

1-2. PINEAL GLAND

a. **Description.** The pineal gland is located just posterior to the third ventricle in the brain. The name was chosen because this gland resembles a pine cone. The pineal gland starts to calcify (becomes hard due to deposit of calcium salts) at about the time of puberty. These calcium deposits are referred to as brain salts.

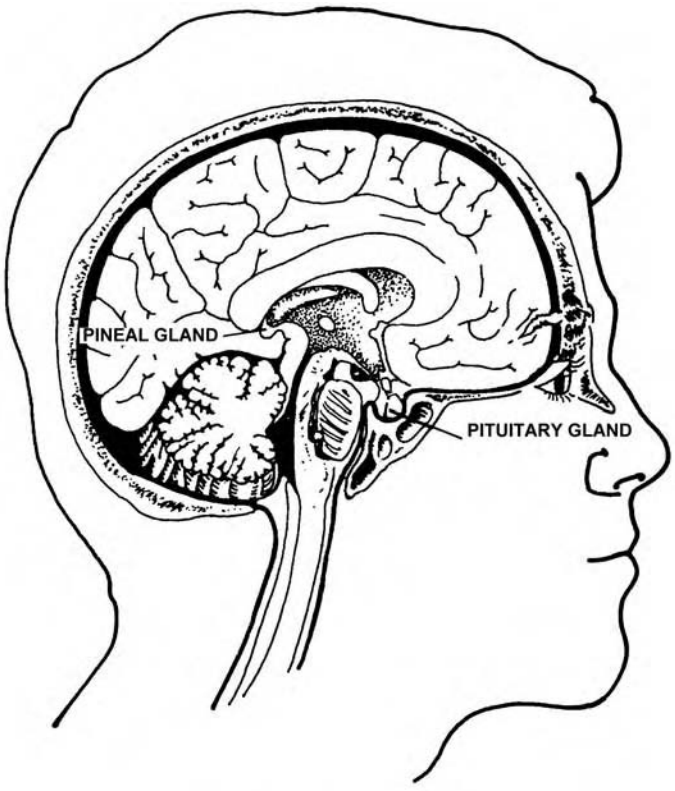

Figure 1-2. The pineal gland and the pituitary gland.

b. **Hormones.** Scientists are not sure of the effect of the hormones secreted by the pineal gland. It is known that this gland causes animals to come into heat. Research indicates the following in regard to humans:

(1) Melatonin. This hormone seems to be secreted on a day/night cycle with the highest production at night and the lowest production during the day. Its function is to prevent ovarian secretion.

(2) Serotonin. This hormone seems to prevent extremes in the blood vessels of the brain. If blood vessels in the brain seem too small, serotonin dilates the vessels (makes them wider). The levels of this hormone are highest at noon and lowest at midnight.

(3) Glomerulotropin. This hormone stimulates the secretion of adrenal aldosterone.

1-3. PITUITARY GLAND

a. **Description.** The pituitary gland is small weighing only about 600 mg; however, it is a key organ. The pituitary gland influences every structure and system in the body. Structurally and functionally, the pituitary gland is divided into two lobes: the anterior lobe and the posterior lobe.

b. **Anterior Lobe--Hormones.**

(1) Adrenocorticotropic hormone (ACTH). This hormone is secreted by the anterior lobe of the pituitary gland. ACTH stimulates the adrenal cortex to produce steroid hormones. A primary action of ACTH is to promote and maintain normal growth and development of the adrenal cortex.

(2) Follicle-stimulating hormone (FSH). FSH stimulates the normal growth cycle of the ovarian follicle in females. In males FSH stimulates the seminiferous tubules (tubes that convey semen) to produce spermatozoa.

(3) Growth hormone (GH). This hormone promotes fat mobilization, prevents glucose from being used, and affects the rate of skeletal and visceral (internal organs) growth. Too much of this hormone can cause diabetes. Also, an excess of this hormone in early life can cause a child to become a giant. Too little of this hormone is early life can cause an infant to become a dwarf. Another name for GH is somatotropin.

(4) Interstitial cell stimulating hormone (ICSH). ICSH stimulates testicular interstitial cells in the male to produce androgen, a substance that stimulates the development of male sex characteristics. This hormone in the male is the same as the luteinizing hormone in the female which is essential for ovulation (discharge of an ovum from the mature follicle of the ovary).

(5) Luteinizing hormone (LH). LH promotes the maturation of the ovarian follicle; secretion of progesterone; ovarian follicle to release the ovum; and the conversion of the ruptured follicle into the corpus luteum (the scar tissue which forms the ruptured follicle).

(6) Pituitary growth hormone (PGH). PGH is a growth hormone. Also known as the somatotropic hormone (STH), this hormone turns on body cells to grow. The principal function is to increase the rate of growth of body cells and to maintain their size once growth is attained. The growth hormone also increases the rate of protein synthesis and promotes a process called fat catabolism. Fat catabolism causes cells to switch from burning carbohydrates to burning fats for energy.

c. **Posterior Lobe--Hormones.**

(1) Antidiuretic hormone (ADH). This hormone has a potent antidiuretic action. ADH makes the collecting duct of the kidney permeable to water and allows reabsorption of water and concentration of urine in the kidney.

(2) Oxytocin. Oxytocin is formed in the base of the brain (hypothalamus) and stored in the posterior lobe of the pituitary gland. This hormone stimulates smooth muscle and causes strong contractions of the uterus and the ejection of milk from the breast.

NOTE: Oxytocin is not to be confused with the hormone prolactin which stimulates the production of milk.

1-4. THYROID GLAND

a. **Description.** The thyroid gland is located just below the larynx with a right and left lateral lobe on either side of the trachea. A mass of tissue called an isthmus lies in front of the trachea and connects the two lateral lobes of the thyroid gland. The thyroid gland weighs about 25 grams and receives a rich supply of blood (about 80 to 120 ml per minute).

b. **Hormones.** Thyroid hormones have three principal effects on the body. They regulate the body's metabolism rate; regulate the body's growth and development; and regulate the activity of the nervous system. To fulfill these functions, the thyroid gland releases these hormones; tetraiodothyronine (thyroxine or T_4) and triiodothyronine (T_3). Both of these hormones contain iodine. Iodine collects in the thyroid gland in the process of thyroid hormones being made.

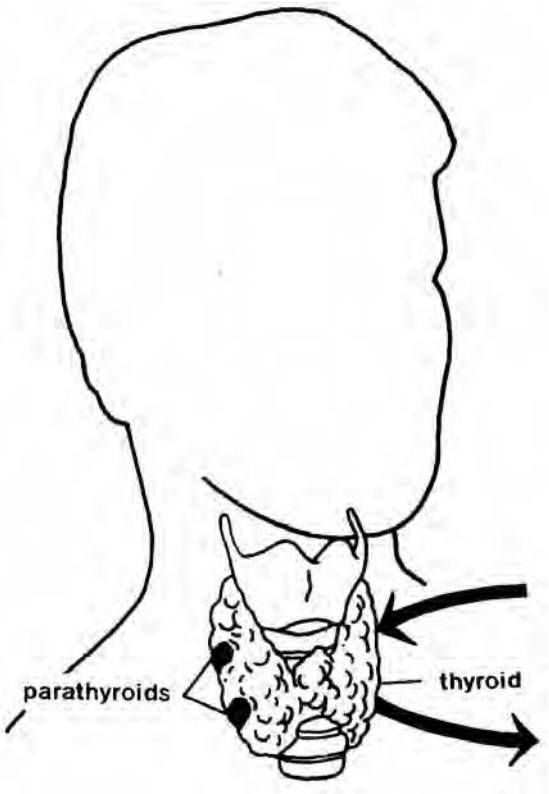

Figure 1-3. The thyroid gland and the parathyroid glands.

1-5. PARATHYROID GLANDS

a. **Description.** The parathyroid glands are tiny bean-shaped glands embedded on either side of the thyroid gland. There are usually four parathyroid glands, but there may be more. The upper parathyroids are usually located at the point where the upper and middle third of the thyroid gland meet. The lower parathyroids are usually located in the branches of the inferior thyroid artery, but these parathyroids may be located in the chest.

b. **Hormones.** The parathyroid glands secrete the hormone parathormone. This hormone regulates the concentration of calcium and phosphorus in the blood. Parathormone also influences the passage of calcium and phosphorus among the bloodstream, bones, and urine.

1-6. ADRENAL GLANDS

a. **Description.** The adrenal glands are located above the kidneys. The adrenal cortex is the outer part of the gland, and the medulla is the inner portion of the gland.

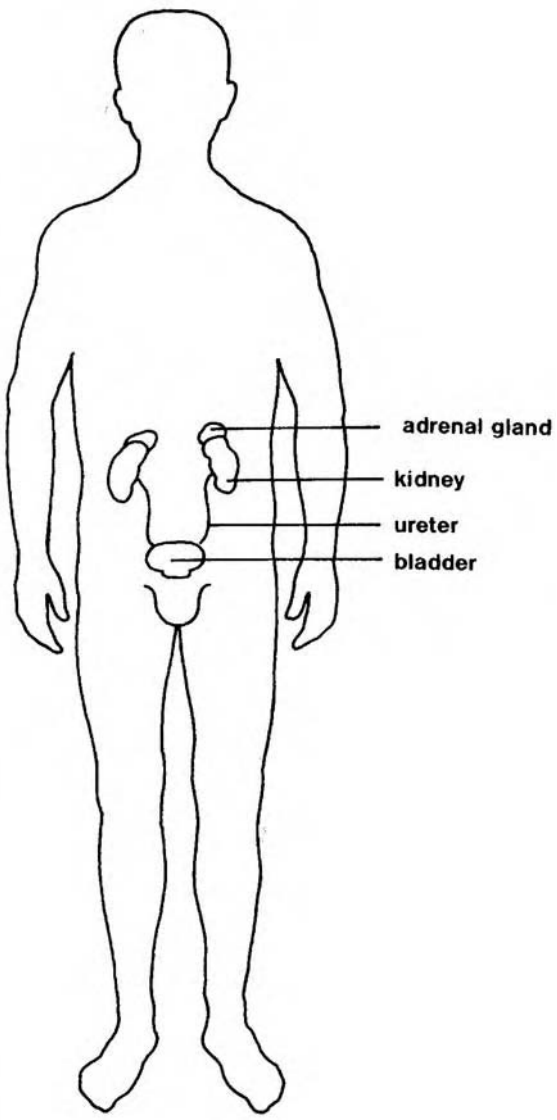

Figure 1-4. The adrenal glands.

b. **Hormones.** Glucocorticoids, mineralocorticoids, and small amounts of sex hormones are made and secreted by the adrenal cortex. All together, these hormones are called corticosteroids. Two neurohormones are produced by the adrenal medulla: epinephrine and norepinephrine.

(1) Glucocorticoids. The glucocorticoids secreted by the adrenal cortex aid protein, fat, and carbohydrate metabolism to help the body meet stress conditions. Glucocorticoids accelerate the breakdown of protein to amino acid which is changed to glucose in the liver. In this way, the amount of serum glucose in the body is increased. Glucocorticoids also help the body withstand stress from anxiety or sever injury because the hormone has an anti-inflammatory effect. Catecholamine hormones, a type of glucocorticoid hormone, are commonly known as the "fight or flight" hormones because these hormones give the body extra energy in stressful situations.

(2) Mineralocorticoids. Mineralocorticoids keep mineral salt metabolism in balance which, in turn, helps to maintain the body's electrolyte and fluid intracellulary balance. Aldosterone, a mineralocorticoid, regulates the metabolism of sodium, chloride, and potassium. Aldosterone causes sodium to be absorbed into the blood which leads to water being reabsorbed in the farthest renal tubules. Proper levels of aldosterone also cause potassium to be excreted and aids in the maintenance of normal blood Ph.

1-7. PANCREAS

a. **Description.**

(1) Functions. The pancreas is a gland with two major functions, one an endocrine function and the other an exocrine function. As an endocrine organ, the pancreas produces the hormone insulin. As an exocrine organ, the pancreas produces a variety of enzymes (protein-digesting enzymes, fat-digesting enzymes, and carbohydrate-digesting enzymes).

(2) Composition. The pancreas, located slightly behind and toward the top of the stomach, is composed of three parts: a head, body, and tail. The average length is about six inches, and the average weight is about three ounces. The endocrine portion of the pancreas is called the isles of Langerhans which are clusters of cells. Three kinds of cells are found here: alpha cells, beta cells, and delta cells.

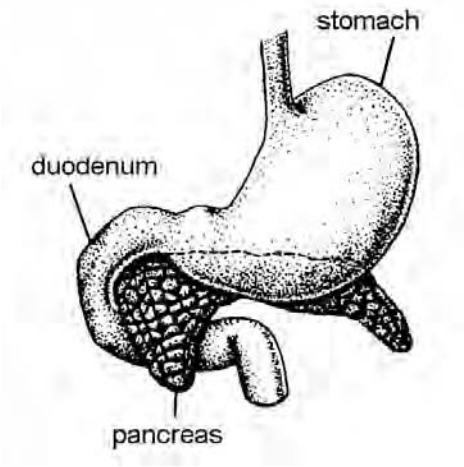

Figure 1-5. The pancreas.

b. **Hormones.** Alpha cells secrete the hormone glucagon which acts primarily on the liver. Alpha cells increase the body's blood sugar level by causing sugar to be removed from storage in the liver and transferred to the blood. Beta cells secrete insulin which affects most body cells. Insulin causes a decrease in blood sugar by increasing the ability for body cells to take up and use sugar. Beta cells promote storage of sugars and fats on body tissue and promote building of body protein. Delta cells secrete somatostatin, a hormone which inhibits growth.

1-8. GONADS

a. **Description.** The gonads are the sex glands. In the female, the gonads are the ovaries which are located in the pelvic cavity. In the male, the gonads are the testes which are located in the scrotum. These glands give the primary sex characteristics in the growth and development of the primary reproductive organs at puberty. These glands are also responsible for the secondary sex characteristics.

b. **Hormones.**

(1) Hormones in females. The ovaries, in the female, produce estrogen, progesterone, and relaxin. Estrogen is responsible for stimulating the development of the female sex organs and secondary sexual characteristics of voice pitch, broad pelvis, and hair pattern. Progesterone acts with estrogen to regulate menstruation. Relaxin causes the birth canal to widen.

(2) Hormones in males. The testes, in the male, produce the hormone testosterone. Testosterone is the principal male hormone and has a number of effects on the body. First, this hormone controls the development, growth, and maintenance of the male sex organs. Additionally, the hormone stimulates bone growth, sexual behavior, final maturation of sperm, and development of male secondary sex characteristics. Secondary male sex characteristics include the following:

(a) Muscular and skeletal development such as wide shoulders and narrow hips.

(b) Body hair patterns that include pubic hair, armpit hair and chest hair, facial hair, and hair recession at the temple.

(c) Enlargement of the thyroid cartilage of the larynx which produces the deepening of the male voice.

NOTE: Testosterone is also responsible for stimulating the descent of the testes just before a male is born.

1-9. CLOSING

The interworking of the endocrine system with all other systems is a remarkable and delicate balance. As you evaluate your patients, you will not be looking for diseases of the adrenal medulla or thyroid gland but the symptoms of what their malfunction will show. Keep in mind that your patient's body is a complex machine where every part affects another part.

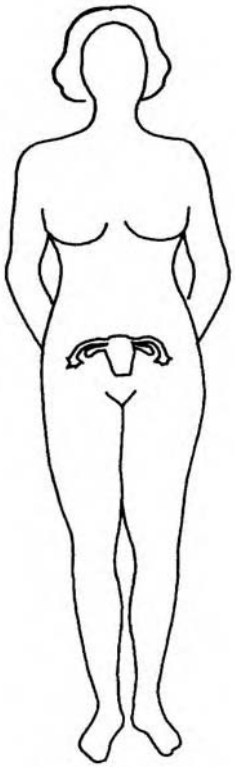

Figure 1-6. Location of female gonads.

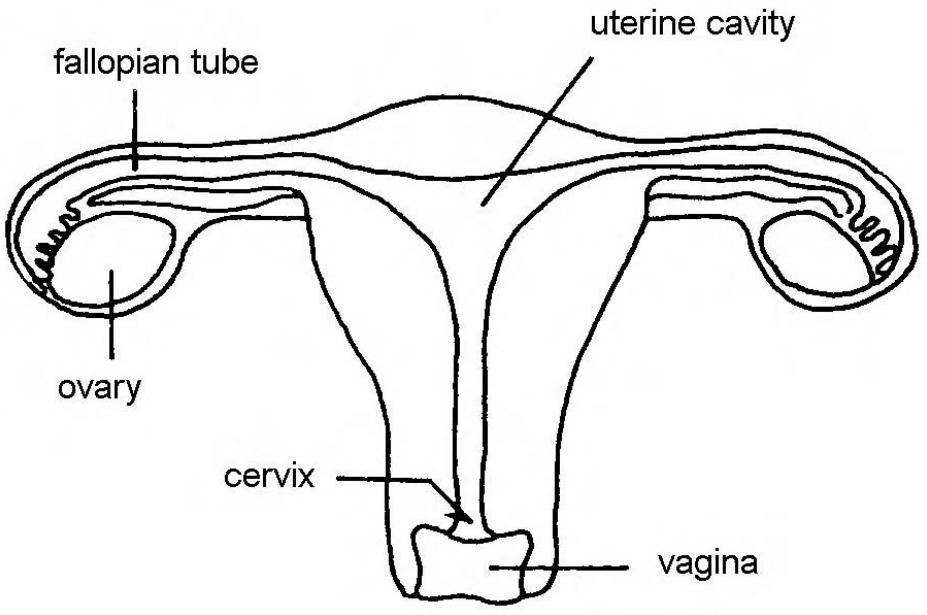

Figure 1-7. Female gonads.

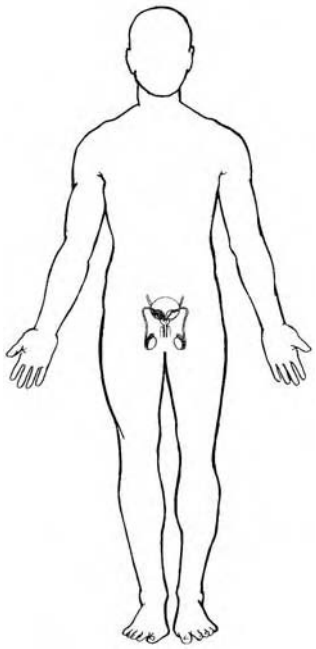

Figure 1-8. Location of male gonads.

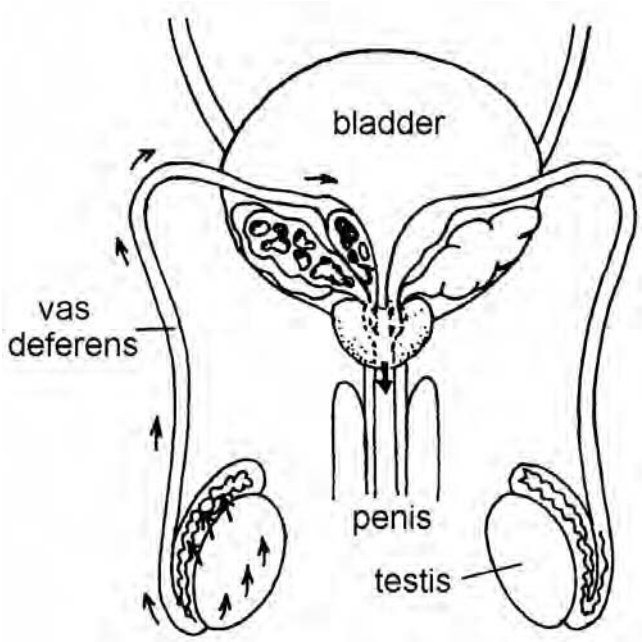

Figure 1-9. Male gonads.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS. The following exercises are to be answered by writing the answer in the space provided. After you have completed all the exercises, turn to the solution at the end of the exercises and check your answers.

1. The _____ gland, located in front of the neck at the junction of the larynx and the trachea, secretes a hormone that aids in the regulation of the body's metabolic rate.

2. The _____ glands, the smallest of the endocrine glands, secrete a hormone which regulates the concentration of calcium and phosphorus in the blood.

3. The _____ secretes glucorticoids which help the body meet conditions of stress.

4. A small cone-shaped gland, the _____ gland, is located inside the cranial cavity, secretes the hormone melatonin which seems to inhibit reproductive activities.

5. The alpha cells of the _____ secrete glucagon, a hormone produced when the body's blood sugar gets too low.

6. _____ cells secrete insulin (hypoglycemic hormones) which causes a decrease in blood sugar by increasing the body's ability to take up and use sugar.

7. The hormone somatostatin is produced by the _____.

8. A principal effect of the _____ gland is to regulate the body's metabolic rate.

9. _____ is the hormone which releases the milk formed by the glandular cells of the nursing female.

10. The adrenocorticotropic hormone (ACTH) has the primary action of _____ _____.

11. The _____ hormone is secreted by the anterior lobe of the pituitary gland and stimulates the normal growth cycle of the ovarian follicle in females.

12. _____ hormone is secreted by the posterior lobe of the pituitary gland. This hormone makes the collecting duct of the kidney permeable to water and allows concentration of water.

13. The hormone which promotes the maturation of the ovarian follicle as well as the secretion of progesterone is the _____ hormone.

14. The hormone which works with estrogens to regulate menstruation is _____.

15. The hormone responsible for the secondary sex characteristics of voice pitch, broad pelvis, and hair pattern in women is _____.

16. The hormone responsible for secondary sex characteristics in men is _____

17. The gland responsible for animals coming into heat is the _____ gland.

18. The mineralocorticoid (secreted by the adrenal glands) help maintain _____ balance and _____ balance.

19. The catecholamine hormones epinephrine and norepinephrine (secreted by the adrenal medulla) are commonly known as the _____ hormones because they give the body extra energy in stressful situations.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. Thyroid (paras 1-4a, b)
2. Parathyroid (paras 1-5a, b)
3. Adrenal cortex (para 1-6b)
4. Pineal (paras 1-2a, 2b(1))
5. Pancreas (para 1-7b)
6. Beta cells (para 1-7b)
7. Delta cells (para 1-7b)
8. Thyroid (para 1-4b)
9. Oxytocin (para 1-3c(2))
10. Promoting and maintaining normal growth and development of the adrenal cortex. (para 1-3b(1))
11. Follicle-stimulating (para 1-3b(2))
12. Antidiuretic (para 1-3c(1))
13. Lutenizing (para 1-3b(5))
14. Progesterone (para 1-8b)
15. Estrogen (para 1-8b)
16. Testosterone (para 1-8b(2))
17. Pineal (para 1-2b)
18. Electrolyte, fluid (para 1-6b(2))
19. Fight or flight (para 1-6b(1))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Diseases and Disorders of the Endocrine System.
LESSON ASSIGNMENT	Paragraphs 2-1 through 2-7.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

2-1. Identify the signs, symptoms, and treatment for the thyroid gland disorders hyperthyroidism and adult hypothyroidism.

2-2. Identify the signs, symptoms, and treatment for the adrenal gland disorders Addison's disease, Cushing's disease, Conn's syndrome, and pheochromocytoma.

2-3. Identify the signs, symptoms, and treatment for the anterior lobe adrenal gland disorders hypersecretion and hyposecretion.

2-4. Identify the signs, symptoms, and treatment for the parathyroid glands disorders hyperparathyroidism and hypoparathyroidism.

2-5. Define the Islands of Langerhans disorders of hypersecretion of insulin and hyposecretion of insulin.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

DISEASES AND DISORDERS OF THE ENDOCRINE SYSTEM

2-1. INTRODUCTION

The function of the endocrine system is to help the nervous system regulate the processes of the body; for example, growth, metabolic rate, etc. Therefore, disease in any part of the endocrine system will cause problems in several body functions. This lesson examines some of the diseases and disorders of the endocrine system.

2-2. DISEASES OF THE THYROID GLAND

a. **Hyperthyroidism (Graves Disease).**

(1) Description. Hyperthyroidism is an imbalance in the body's metabolism caused by excessive production of the thyroid hormone. Too much thyroxine is produced which leads to many changes in the body, a most noticeable change being an enlarged thyroid gland in the neck--a goiter. This condition occurs chiefly in the 30 to 40 age group. Only five percent of patients with this condition are under age 15.

(2) Signs and symptoms. Excessive production of the thyroid hormone causes changes in many of the body systems. Central nervous system changes include excitability or nervousness and a tremor in the hands. Cardiovascular system changes include tachycardia and a full, bounding pulse. Respiratory changes include labored breathing, and a higher incidence of spontaneous abortions is one of the changes in the reproductive system. Not all these changes always occur in a patient with hyperthyroidism. The most common body changes, characteristic of Graves' disease, a type of upper thyroidism, and are listed below.

(a) Enlarged thyroid gland, commonly called a goiter.

(b) Heat intolerance and unusual sweating.

(c) Nervousness and weakness.

(d) Overactivity combined with irritability and fatigue.

(e) Unexplained weight loss, usually with increased appetite.

(f) Exophthalmos (protruding eyes), a fixed stare, and a lack of visual accommodation. (Protruding eyes are caused by the effects of accumulated intracellular material and fluids in the tissues behind the eye which force the eyeball outward. Sometimes the eyelids retract causing the patient to look as if he is staring.)

(g) These signs/symptoms can increase in intensity suddenly. This condition is called Thyroid storm. It is dangerous and can be fatal. Signs and symptoms can be accompanied by extreme irritability, hypertension, tachycardia, vomiting, and a temperature up to 106 F. Final stages include delirium followed by coma.

NOTE: A nodular (lumpy) goiter with no exophthalmos (protruding eyeball) indicates Plummers' disease. This condition is less dangerous than Graves' disease.

(3) Treatment.

(a) Primary treatment for hyperthyroidism. The two main types of treatment are antithyroid drugs and surgery. Method of treatment depends on the size of the goiter, the causes, the patient's age and whether or not pregnant, and how long before surgery could be performed (if surgery is one the patient's options). In the past, surgical removal of the goiter has been the most widely used method of treatment. Antithyroid drug therapy includes use of thyroid hormone antagonists such as propylthiouracil (PTU) and methimazole. Both drugs reduce the production of the thyroid hormone thyroxin. Another form of treatment is a single dose of I_{131}, a radioactive element which destroys some of the thyroid gland's cells that normally produce thyroxin. The result is that thyroid hormone production decreases, and the thyroid gland decreases to its normal size. At its normal size, the gland produces only the normal amount of the hormone thyroxin.

(b) Thyroid storm treatment. Drug therapy is used. Other measures include such supportive treatment as nutrients, vitamins, giving fluid, and sedation, if necessary.

b. **Adult Hypothyroidism (Myxedema).**

(1) Description. Hypothyroidism is the reverse of hyperthyroidism. The thyroid gland produces too much thyroxin in hyperthyroidism. The condition hypothyroidism is caused when the thyroid gland produces too little thyroxin. Lack or complete absence of thyroid gland activity from birth causes cretinism. Cretinism is a dwarfed, mentally retarded state due to a failure of physical growth and mental development. Early detection and treatment of this condition can prevent abnormal physical development and mental retardation. Children under one year can be treated.

(2) Early signs/symptoms.

(a) Fatigue.

(b) Forgetfulness.

(c) Sensitivity to cold.

(d) Unexplained weight gain.

(e) Constipation.

(3) Later signs/symptoms.

(a) Decreasing mental stability.

(b) Dry, flaky, inelastic skin.

(c) Puffy face, hands, feet.

(d) Hoarseness.

(e) Edema around the eyes.

(f) Upper eyelids droop.

(g) Dry, sparse hair.

(h) Thick, brittle nails.

(4) Still later signs/symptoms.

(a) Gradual or sudden coma.

(b) Progressive stupor.

(c) Hypoglycemia.

(d) Hypotension.

(5) Treatment. Treat by giving thyroid extract or synthetic thyroid preparation usually by mouth. The drugs of choice are Synthroid and Levothroid.

(6) Diagnostic tests.

(a) Thyroxin test (T_4). This is a blood test which measures the amount of thyroxin in the blood. The level of thyroxin in the blood will be lower in hypothyroidism and higher in hyperthyroidism.

(b) Radioactive iodine uptake test. This test measures the amount of radioactive iodine (I131) which the thyroid gland metabolizes. The patient is given radioactive iodine orally or intravenously. Then, a scintillation camera scans the thyroid gland and produces a pattern which shows the size of the gland. If the patient is given radioactive iodine orally, the test will be done twenty-four hours later. Iodine administered intravenously allows the test to be performed thirty minutes later. There are no fluid or food restrictions for a patient having this test. Several factors affect the test results causing the results to be invalid. These factors include:

1 The patient has been taking drugs and estrogens containing iodine in the last thirty days (adrenocorticosteroids, sulfonamide, contraceptives).

2 The patient has had x-ray studies using iodine containing media.

3 The patient has eaten a lot of seafood recently.

(c) Thyrotropin test (TSH). This test measure the thyroid gland response to pituitary hormone stimulus.

2-3. DISEASES OF THE ADRENAL GLANDS

a. Addison's Disease (Adrenal Hypofunction).

(1) Description. Addison's disease is a condition resulting from adrenocortical insufficiency; that is, the adrenal gland is not functioning enough. The adrenal gland has either degenerated or stopped functioning.

(2) Signs and symptoms. Typical signs and symptoms include:

(a) Weakness, fatigue, weight loss.

(b) Swollen lymph nodes.

(c) Conspicuous bronze coloration of light-colored skin.

(d) Dehydration, hypotension, small heart size.

(e) Anorexia, nausea, vomiting, and diarrhea.

(f) Nervous and mental irritability.

(g) Faintness after missing meals.

(h) Decreased tolerance to cold and hypometabolism (lowered metabolism rate).

(i) Scant to absent armpit and pubic hair (especially in women).

(j) Absence of sweating.

(k) Severe dental caries.

(3) Treatment. Give steroid medications such as cortisone or hydrocortisone.

b. **Cushing's Disease.**

(1) Description. Also called Cushing's syndrome, this is a group of abnormalities caused by too high a level of adrenocortical hormones.

(2) Signs and symptoms. This condition causes changes in many of the body's systems. Common signs and symptoms are:

(a) Obesity with a round face ("moon face").

(b) Impotence in the male.

(c) Weakness.

(d) Backache.

(e) Hypertension.

(f) Excessive hair growth.

(g) Purple bands (striae), especially around the thighs, breasts, and abdomen.

(h) Dental caries (tooth decay).

(3) Treatment. There are three possibilities: irradiation; drug therapy; or surgery. The type of treatment selected depends on the condition of the individual patient.

c. **Conn's Syndrome (Hyperaldosteronism).**

(1) Description. This condition, the adrenal cortex secretes too much mineral-ocorticoid aldosterone (a steroid in the adrenal cortex that controls salt metabolism). The result is that the body reabsorbs too much sodium and water, and the kidneys excrete too much potassium.

(2) Signs and symptoms. Included are the following:

(a) Decline in potassium level in the blood (hypokalemia) which results in muscle weakness.

(b) Concentration of urine by the kidneys is difficult (polyuria).

(c) Elevation in blood sodium (hypernatremia) which results in excessive thirst (polydipsio) and high blood pressure (hypertension).

(3) Treatment. One possible treatment is unilateral adrenalectomy (removal of the adrenal gland). Another possible treatment is administration of spironolactone (a potassium- sparing diuretic) and sodium restriction; this treatment has been successful in controlling the condition without surgery.

d. **Pheochromocytoma.**

(1) Description. A pheochromocytoma is a tumor of the chromaffin cells which is usually found in the adrenal medulla.

(2) Signs and symptoms. Included are:

(a) Hypertension.

(b) Tachycardia.

(c) Tremor.

(d) Excessive perspiration.

(e) Hyperglycemia.

(f) Polyuria (passage of abnormally large quantities of urine).

(g) Gastrointestinal symptoms such as abdominal pain, nausea, vomiting.

(h) Abnormal sensation (burning, tingling, or numbness) in the extremities, possibly.

(3) Treatment. Usually, the tumor is removed surgically.

2-4. DISEASES OF THE PITUITARY GLAND--ANTERIOR LOBE

a. **Hypersecretion (Hyperpituitarism, Acromegaly, Gigantism).**

(1) Description. The pituitary gland secretes too much of the growth hormone. If this occurs in children, the result is giantism (an abnormal skeletal development). Excessive production of the growth hormone when an individual is an adult causes acromegaly (head, face, hands, feet, and internal organs get progressively larger). In giantism, the people are generally large but usually very weak. In acromegaly, the bones of the face, hands, and feet widen. The jaw protrudes, and the forehead bones bulge.

(2) Signs and symptoms. The condition acromegaly develops slowly and produces a variety of symptoms including excessive sweating, oily skin, a high metabolic rate, and heavy hair growth in places where the hair growth is usually light; for example, on the female face. In contrast, giantism seems to develop rapidly. As giantism progresses, the pituitary tumor which causes the condition gets bigger causing disturbances in other systems of the body. Treatment includes irradiation or surgical removal of the tumor.

b. **Hyposecretion.**

(1) Description. The condition occurs when not enough hormones are secreted by the anterior lobe of the pituitary gland. The result is metabolic dysfunction, sexual immaturity, and growth retardation when the problem takes place in childhood. In an adult, insufficient amounts of these hormones results in a condition called Simmond's disease. Signs and symptoms include emaciation (extreme thinness), asthenia (severe weakness or loss of strength), lowered metabolic rate, low temperature, and low blood pressure. The cause of this deficiency in the production of hormones is usually trauma, tumor, or hemorrhage.

(2) Treatment. Treatment is either surgical removal or x-ray irradiation if there is a tumor. Drug therapy to replace needed hormones is very effective. Cortisol, thyroxin, and androgen or cyclic estrogen may be prescribed.

2-5. DISEASES OF THE PARATHYROID GLANDS

a. **Hyperparathyroidism.** One or more of the parathyroid glands enlarges. Too much parathyroid hormone is secreted, and the serum calcium level becomes too high. There is a change in the function of cells of the bone, renal tubules, and gastrointestinal mucosa. The withdrawal of calcium from bones (osteoporosis) leads to hypercalcemia (abnormally high concentration of calcium in the blood) and kidney stones. Other signs and symptoms include muscular weakness, gastrointestinal symptoms such as anorexia, nausea, vomiting, and abdominal pains. Treatment depends on the diagnosis of the cause of the condition. Surgical removal of the parathyroid tissue is often the treatment.

b. **Hypoparathyroidism.** This condition is the result of insufficient amounts of the parathyroid hormone (PTH) being produced by the parathyroid glands. The cause can be disease, injury, or a malfunction of these glands which was present at birth. This hormonal insufficiency leads to lower than normal blood concentration of calcium resulting in muscle spasms and convulsions. There can be dermatologic, ophthalmologic (cataracts), psychiatric, and dental symptoms of this condition. Treatment is the replacement of calcium in the body.

2-6. ISLANDS OF LANGERHANS (IN THE PANCREAS).

The islands or islets of Langerhans consist of clusters of cells that make up the endocrine portion of the pancreas. These cells produce hormones. These cells can be classified as A cells, B cells, D cells, and F cells depending on the hormone produced by each type of cell. The most numerous cells are B cells which produce insulin. Two types of disorders result if the B cells do not produce the necessary quantity or quality of insulin: hyposecretion of insulin and hypersecretion of insulin.

a. **Hyposecretion of Insulin.** Too little insulin is secreted. There is sugar in the urine, and the level of blood sugar is abnormally high. These are characteristics of diabetes mellitus, a disease discussed in lesson 3.

b. **Hypersecretion of Insulin.** Too much insulin is secreted by the cells in the islands of Langerhans. The result is hypoglycemia which is abnormally low levels of blood sugar. The signs and symptoms of this condition include sweating, hunger, weakness, and lightheadedness. The symptoms often disappear after the patient eats a snack.

2-7. CLOSING

These diseases and disorders may not be life-threatening, but they can be painful and a detriment to the soldier's completion of duty. Management of patients with these health problems can have a great impact on the Army's ability to complete the mission.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS. The following exercises are to be answered by writing the answer in the space provided. After you have completed all the exercises, turn to the solution at the end of the exercises and check your answers.

1. What is hyperthyroidism? Hyperthyroidism is _____

   _____

2. List three signs/symptoms of hyper-thyroidism.

   a. _____

   b. _____

   c. _____

3. Myxedema, also referred to as _____, is caused when the thyroid gland produces _____.

4. List four early signs/symptoms of myxedema.

   a. _____

   b. _____

   c. _____

   d. _____

5. Addison's disease results when the adrenal gland does not produce enough _____ hormones.

6. Typical signs/symptoms of adrenal hypofunction include: (list three).

   a. _____

   b. _____

   c. _____

7. List three signs/symptoms of Cushing's syndrome.

   a. _____

   b. _____

   c. _____

8. In Conn's syndrome, the adrenal cortex secretes too much mineralocorticoid with the result that the body reabsorbs too much _____ and _____, and the kidneys excrete too much.

9. A _____ is a tumor which occurs in the chromaffin cells. This tumor is usually found in the adrenal medulla.

10. Gigantism can be caused when the _____ gland secretes too much of the growth hormone.

11. _____ can occur when the anterior lobe of the pituitary gland does not secrete enough hormones.

12. _____ is a condition caused by not enough parathyroid hormone being produced by the parathyroid glands.

13. Sometimes too much parathyroid hormone is secreted, and one or more of the parathyroid glands enlarges. The name of this condition is _____

14. The islands of Langerhans are clusters of cells making up the endocrine part of the _____. Insulin is produced by the _____cells in the islands of Langerhans.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. An imbalance in the body's metabolism caused by excessive production of the thyroid hormone. (para 2-2a(1))

2. You are correct if you listed any three of the following:

   Enlarged thyroid gland.
   Heat intolerance/unusual sweating.
   Nervousness/weakness.
   Overactivity plus irritability/fatigue.
   Unexplained weight loss with increased appetite.
   Exophthalmos, fixed stare, decreased visual accommodation. (para 2-2a(2))

3. Adult hypothyroidism, too little thyroxin. (para 2-2b(1))

4. You are correct if you listed any four of the following:

   Fatigue.
   Forgetfulness.
   Sensitivity to cold.
   Unexplained weight gain.
   Constipation. (para 2-2b(2)(a))

5. Adrenocortical. (para 2-3a)

6. You are correct if you listed any three of the following:

   Weakness, fatigue, weight loss.
   Swollen lymph nodes.
   Conspicuous bronze coloration of light skin.
   Dehydration, hypotension, small heart size.
   Anorexia, nausea, vomiting, diarrhea.
   Nervous and mental irritability.
   Faintness after missing meals.
   Decreased tolerance to cold.
   Scant to absent armpit/pubic hair.
   Absence of sweating.
   Sever dental caries (cavities). (para 2-3a(2))

7. You are correct if you listed any three of the following:

   Obesity with a round face.
   Impotence in the male.
   Weakness.
   Backache.
   Hypertension.
   Excessive hair growth.
   Purple bands.
   Tooth decay. (para 2-3b(2))

8. Sodium
   Water
   Potassium. (para 2-3c(1))

9. Pheochromocytoma. (para 2-3d(1))

10. Pituitary. (para 2-4a(1))

11. Growth retardation. (para 2-4b(1))

12. Hypoparathyroidism. (para 2-5b)

13 Hyperparathyroidism. (para 2-5a)

14. Pancreas.
    B. (para 2-6)

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Diabetes Mellitus.
LESSON ASSIGNMENT	Paragraphs 3-1 through 3-11.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

3-1. Define diabetes mellitus.

3-2. Identify the factors that increase the risk of diabetes mellitus.

3-3. Define Type I and Type II diabetes.

3-4. Identify the signs, symptoms, and treatment of diabetes mellitus.

3-5. Define insulin shock and identify the signs, symptoms, and treatment for insulin shock.

3-6. Identify the causes, signs, symptoms, and treatment for hyperglycemia and ketoacidosis.

3-7. Identify characteristics of these diabetic health problems: vascular disturbances, visual problems, neuropathy, and infection.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

DIABETES MELLITUS

3-1. INTRODUCTION

a. **Definition**. Diabetes is a term which refers to diseases characterized by excessive urination. Used alone, the word diabetes refers to diabetes mellitus. Diabetes, a disease that affects the way the body uses food, causes sugar levels in the blood to be too high.

b. **Normal Digestive Process**. In the digestive process, the body changes sugars, starches, and other foods into a form of sugar called glucose. The blood carries this glucose to cells throughout the body. Insulin (a hormone) in the body's cells changes glucose into quick energy which can be used immediately by the cells or stored for future needs. (Beta cells in the pancreas produce insulin). The body's process of turning food into energy is critical for survival since the body depends on food for every action--running, jumping, swimming, thinking, pumping blood, etc.

c. **Diabetic Digestive Process**. For the diabetic patient, the body does not turn food into energy in the normal way. The body does change food into glucose, but a problem arises in the production of insulin. In one type of diabetes (Type I diabetes), the pancreas cannot make insulin. In another type of diabetes (Type II diabetes), the pancreas either does not make enough insulin or the body cannot use the insulin or both conditions occur. Without insulin performing its function, cells in the bloodstream can not use glucose to make energy. What happens is that glucose collects in the blood giving the diabetic person high sugar levels in the blood, a sign of untreated diabetes.

d. **General Information**. Diabetes is a widespread disease affecting about 11 million people or nearly one in every twenty people. Roughly 1 million people have insulin-dependent diabetes (Type I diabetes). Approximately 10 million persons have non-insulin-dependent diabetes. Additionally, there are about 5 million people who have non-insulin-dependent diabetes and do not know they are diabetics. While diabetes cannot be cured, the disease can be managed effectively.

3-2. FACTORS THAT INCREASE THE RISK OF DIABETES MELLITUS

A number of factors influence the risk of a person having diabetes mellitus. Chief among these factors are over 40, overweight, and a family history of diabetes. Persons with these characteristics should see a doctor periodically to be tested for diabetes. For some reason, obesity causes the body to resist using the insulin it produces. Another factor is that the disease tends to be more common among women than men. Women giving birth either to many babies or very large babies are at risk. Other factors include pancreatic disease, injury, or tumor. Some medications are known to increase the risk of diabetes; for example, steroids (adrenal corticosteroids) and thiazides (thiazide

diuretics). Stress--psychological or emotional--is considered a risk factor regardless of what causes the stress (surgery, infection, pregnancy, the environment, and so forth).

3-3. TYPES OF DIABETES MELLITUS

There are two main types of diabetes mellitus: insulin-dependent and non-insulin-dependent. There are other less common types of diabetes.

a. **Insulin-Dependent (Type I) Diabetes (IDDM)**. This type usually occurs before age 30 but may occur at any age. It used to be called juvenile-onset diabetes because it occurred most often in children and young adults. Research revealed that IDDM could occur at any age; therefore, the name was changed. The patient is usually thin, needs insulin medication, and must adjust his diet to control the disease. Typically, the pancreas either stops making insulin or does not make enough insulin. Insulin must be injected every day to help turn food into energy for survival.

b. **Noninsulin-Dependent (Type II) Diabetes NIDDM).** This type of diabetes is the one which usually affects people who are over 40 and overweight. Often diet and exercise can control this form of diabetes. Here the pancreas produces some insulin, but the body is unable to use that insulin effectively. Sometimes insulin medication is required.

c. **Other Types of Diabetes**.

(1) Gestational diabetes. Pregnant women sometimes have this type of diabetes during pregnancy. After the birth of the baby, the disease usually disappears.

(2) Secondary diabetes. Damage to the pancreas from chemicals, particular medicines, or pancreatic disease such as cancer can cause diabetes. In this case, diabetes is secondary, the result of another disease.

(3) Impaired glucose tolerance. This diagnosis means that the level of sugar in the blood falls between a normal level and a diabetic level. Such people have an increased risk of developing diabetes. Terms previously used for this condition include latent diabetes, chemical diabetes, and borderline diabetes. Impaired glucose tolerance is no longer considered a form of diabetes.

3-4. SIGNS/SYMPTOMS OF DIABETES MELLITUS

Listed are signs and symptoms which are typical of the patient who has diabetes. Some individuals who have noninsulin-dependent diabetes have symptoms so mild that neither the person nor anyone else notices.

a. **Signs/Symptoms of Insulin-Dependent Diabetes**. These signs and symptoms usually occur suddenly:

(1) Frequent urination (polyuria).

(2) Excessive thirst (polydipsia).

(3) Extreme hunger (polyphagia).

(4) Sudden weight loss.

(5) Irritability.

(6) Weakness and fatigue.

(7) Nausea and vomiting.

b. **Signs/Symptoms of Noninsulin-Dependent Diabetes**. Signs and symptoms of insulin-dependent diabetes may be present with these additional conditions:

(1) Hard-to-heal skin infections.

(2) Gum or bladder infections which do not heal quickly.

(3) Drowsiness.

(4) Blurred vision.

(5) Tingling or numbness in hands or feet.

(6) Itching.

3-5. ETIOLOGY OF DIABETES MELLITUS

The cause of diabetes mellitus is unknown. Research indicates that the tendency to develop diabetes may be present at birth. Some viral infections seem to trigger the onset of diabetes. Despite the fact that some viruses are believed to help cause diabetes, diabetes is not a disease that one person can catch from another person. Being overweight is a contributing cause to diabetes in those persons who have a tendency toward non-insulin-dependent diabetes. The reason is that too much fat prevents insulin from being used properly by the body.

3-6. DIAGNOSTIC TESTS FOR DIABETES MELLITUS

Diabetes mellitus is a very complex disease; nevertheless, the disease is very easy to detect. Urine normally contains no glucose or acetone, but both are present in the urine of a diabetic patient. Ketone bodies are also present in the urine of a diabetic if fats are metabolized faster than the body can use them. Blood glucose and glucose

tolerance tests may be needed to confirm a diagnosis of diabetes in addition to a test for glucose in the urine. The reason is that glucose in the urine is not always an indication that the person has diabetes. Also, not all diabetics excrete glucose in the urine.

a. **Urine Tests**.

(1) Glucose tests. These are common methods of tests for glucose in the urine:

(a) Tes-tape. Dip a strip of Tes-tape into the urine specimen. The tape will turn green or blue if glucose is present in the urine. Use only the end of the tape that you have not touched with your fingers. Be sure the tape has not previously been exposed to light or air.

(b) Clinitest. Put ten drops of water in a test tube. Add two or five drops of urine (depending on the type of Clinitest used). Put in one tablet of Clinitest. The liquid in the tube will change colors. A Clinitest color chart will show you how to grade the color chart to grade the resulting color of the urine specimen in the test tube.

(c) Diastix. Dip a plastic strip in urine. You can read the strip in thirty seconds.

(2) Ketones. Ketone bodies are present in the urine of diabetic patients. A doctor will decide whether it is necessary to test for ketones. Two tests are Ketostix strips which test the urine for ketones and Keto-Diastix which tests the urine for glucose and ketones. Testing for ketones is especially important when the patient has a fever, is vomiting, or has glucose in his urine.

b. **Blood Tests**. Common tests include the following:

(1) Fasting blood glucose. The patient fasts for eight hours. Then, a single specimen of blood is taken in the morning. Eighty to 120 mg/dl is the normal range.

(2) Postprandial glucose. Two hours after the patient has eaten a high-carbohydrate meal, a single sample of blood is taken. The normal range is 140 to 160 mg/dl.

(3) Oral glucose tolerance test (OGTT). After the patient has fasted for about eight hours, a blood sample and a urine specimen are taken. The patient consumes an oral glucose solution after which blood is drawn at 30 minutes, 1 hour, 2 hours, and 3 hours. A urine specimen is also collected at each of these times. Be sure to label all specimens with the time of collection. In the nondiabetic patient, the blood glucose level returns to normal after two to three hours; the urine sample is negative for glucose. In the diabetic patient, however, the blood glucose levels return to normal more slowly; the urine tests positive for glucose.

3-7. TREATMENT OF DIABETES MELLITUS

The goal in treating diabetes is to keep the patient's blood sugar level in the normal range. A major factor in the management of diabetes is patient education. The patient must realize that diabetes is a lifelong disease which he can manage if he maintains a balance of diet, exercise, and sometimes medications.

a. **Treatment for Insulin-Dependent Diabetes**. Generally, treatment includes insulin injections, regular exercise, and a balanced meal plan that limits the consumption of sugar. This diabetic patient may need to eat three meals per day plus two or three snacks a day. This food will have to be eaten at the same time each day in order to balance insulin which is also given at the same time each day.

NOTE: Food raises the level of blood sugar while insulin lowers the level of blood sugar. Therefore, the effects of food and insulin must be balanced in order to control diabetes.

b. **Treatment for Noninsulin- Dependent Diabetes**. Generally, these patients are treated with a diet plan designed specifically for each patient. The overweight patient must lose weight because fat keeps the body from using the insulin it produces effectively. Sugar intake is restricted, and the patient must follow an exercise plan. The patient may need to take medication, either orally or by injection, if diet and exercise do not bring the blood sugar level in the normal range. Such medication does not correct the blood sugar level alone. The patient must adhere to a special diet and exercise plan, both of which have been designed for him.

c. **Diet**. The amount and kind of food the diabetic patient consumes is most important in controlling this disease. For example, the diabetic who consumes more carbohydrates than he can use or store will eventually develop ketoacidosis. Ketoacidosis (excessive amounts of ketone acids in the body) is a condition which can progress from severe illness to coma to death. If the diabetic patient takes insulin but does not eat enough food, he may develop hyperinsulinism (insulin shock) which results in hypoglycemia (lower than normal level of glucose in the blood). The results are the same as for ketoacidosis. It is very important for the diabetic patient to eat both the right kind of food and the right amount of food. A special diet is prescribed for each diabetic based on that person's sex, age, height, weight, activity, state of health, former dietary habits, and cultural background. General rules include the following:

(1) The diet will include a balance of calories, percentages of carbohydrates, fats, and proteins.

(2) These foods are usually excluded: sugar, candy, honey, jam, jelly, marmalade, preserves, syrup, molasses, pie, cake, cookies, condensed milk, chewing gum containing sugar, and non-diet soft drinks.

(3) The patient must remember that alcohol is high in calories and that any alcoholic drink he consumes must be counted into his total caloric intake.

(4) The diabetic patient can usually have as much as he wants of these foods: unsweetened gelatin, clear and fat-free broth, unsweetened pickles, cranberries, rhubarb, coffee, tea, and certain salads.

(5) Before eating any dietetic foods, the diabetic patient should consult his physician. Additionally, a diabetic patient should remember to count these foods in his diet and to read the label of these foods. Sugar, fat, and protein contents should be listed. "Low calorie" and "dietetic do not always mean "no sugar."

d. **Medications**. Oral hypoglycemic agents (Sulfonylureas) will stimulate the pancreas to produce and release insulin. Sulfonylureas are not insulin. When there is some pancreatic function and when diabetes is unable to be controlled by insulin alone, oral hypoglycemic agents are usually given. Oral hypoglycemic agents are NOT usually prescribed when there is no insulin production and when there is cardiac disease. Some of the oral hypoglycemic agents are tolbutamide (Orinase^{R}), chlorpropamide (diabinese), acetohexamide (Dymelor^{R}), and tolazamide (Tolinase^{R}).

e. **Insulin**. Sources of insulin are animals, genetic engineering of E. Coli. Injectable insulin is obtained from cattle, pigs, and E. Coli. Insulin promotes glucose uptake by cells. There are two categories of insulin: the short-acting and the long-acting types. The short-acting type of insulin has an onset of 30 to 60 minutes and reaches its peak effectiveness at four to six hours. This type of insulin is effective for a period of six to twelve hours. Short-acting insulin agents are Regular, Actrapid, and Semilente. The longer acting type of insulin has an onset of one to two hours and reaches its peak of effectiveness from eight to twelve hours. It has a duration of 24 to 48 hours. The agents of the longer acting insulin type are NPH, Lente, and Lentard. Insulin is not given orally because gastric acids will destroy insulin. Insulin is administered subcutaneously or intravenously in concentration of U-40 (40 units/1 cc) or U-100 (100 units /1cc). Insulin must be stored at 75 degrees Fahrenheit. Freezing temperatures may change the crystal size of insulin.

f. **Exercise**. Proper exercise is important in controlling diabetes mellitus. Exercise improves circulation and helps the body metabolize carbohydrates, both of which decrease the need for insulin. A patient who exercises very little during the week but is more active on the weekends will find that the amount of glucose in his blood varies greatly. If there is no way the patient can exercise more during the week, he should discuss this situation with his physician. His food and insulin requirements may need to be adjusted to fit his activities. A patient should be sure to have some easy to eat carbohydrates with him during exercise in case he feels symptoms of hypoglycemia (weak, sweaty, pale skin, etc.).

g. **Skin and Foot Care**. Breaks in the skin heal more slowly in diabetic patients; therefore, skin and foot care is important to keep the patient's skin soft and supple with a minimum of cracks. These general guidelines should be followed:

(1) Use proper first aid measures even for minor skin abrasions. If redness occurs, consult a physician immediately. Ulcers or gangrene may develop from any break in the skin.

(2) Do not use strong irritating antiseptics such as iodine on breaks in the skin. After using a mild antiseptic, cover the area immediately with sterile gauze. Use fine paper tape or cellulose tape (scotch tape) rather than adhesive tape. Adhesive tape may tear the skin.

(3) Take good care of the feet in order to avoid dry cracked skin. Wash the feet daily with mild soap and lukewarm water. Dry the feet thoroughly but do not rub hard since the skin is delicate. Dry feet can be rubbed with vegetable oil to keep them soft, prevent excess friction, remove scales, and prevent dryness. The patient should wear low heeled shoes that fit comfortably and correctly to prevent shoes rubbing on the feet and creating problems.

3-8. INSULIN REACTION (INSULIN SHOCK)

a. **Definition**. Insulin reaction, also called insulin shock, is defined as low blood sugar. It may be caused by an overdose of insulin or of an oral agent. Increased exercise or a delayed or missed meal may also cause an insulin reaction.

b. **Signs/Symptoms**. Included are the following:

(1) Hypoglycemia. The sugar level in the blood is lower than normal.

(2) Sweating and pale skin.

(3) Hunger.

(4) Irritability.

(5) Dizziness.

(6) Headache.

(7) Tremors.

(8) Palpitations and tachycardia (abnormally fast heart beat).

(9) Lethargy.

(10) Seizures.

(11) Coma.

c. **Treatment**. Insulin shock is a critical situation, and the patient must be treated immediately. Emergency treatment includes the following:

(1) Give a conscious patient orange juice, soft drinks which contain sugar, sugar cubes, or candy to help raise his carbohydrate level.

(2) If the patient is unconscious, do no try to give him something to drink. Instead follow this procedure:

(a) Establish an airway and administer oxygen.

(b) Rub a sugar cube on the patient's tongue. (Do not leave the sugar cube in his mouth. The cube could become lodged in his throat).

(c) Give treatment for complications such as shock or convulsions.

(d) Transport the patient immediately to a medical treatment facility.

(3) A patient will usually improve immediately after consuming sugar. Here is a list of foods that supply an adequate amount of glucose:

(a) Nabisco Animal Crackers (4).

(b) Apple juice (4 ounces).

(c) Orange juice (4 ounces).

(d) Lifesavers (5-6).

(e) Coca-Cola (3 ounces).

(f) Ginger ale (4 ounces).

(g) Corn syrup (2 level teaspoons).

(h) Gumdrops (10 small ones).

(i) Honey (2 level teaspoons).

(j) Wheat peanut butter crackers (3).

(4) You need not worry about the amount of sugar you have given the patient. The doctor at the medical treatment facility will balance the patient's sugar level against insulin production.

NOTE: Diabetic patients have trouble with the level of blood sugar being either too high or too low. If the patient is exhibiting signs of insulin shock (hypoglycemia), give sugar (one of the foods listed in paragraph 3-8c(3)). The person with too high a blood sugar level will not be harmed. And on the other hand, you may save the life of a patient whose blood sugar level is too low.

(5) Frequently, diabetic patients carry a card in the wallet which advises the reader that if the person is behaving strangely, he may be having an insulin reaction or his blood sugar may be too low. The reader is instructed to give the diabetic sugar, candy, fruit juice, or a sweetened drink. The reader is also instructed to call a physician or send the person to a hospital immediately.

3-9. HEALTH PROBLEMS REQUIRING IMMEDIATE CARE

In addition to insulin shock, there are several other conditions a diabetic patient may have, conditions which require immediate attention. Hyperglycemia (high blood sugar) and ketoacidosis (diabetic coma) are two such conditions.

a. **Hyperglycemia**. The level of sugar in the blood is too high in this condition. The patient has probably eaten too much food or not taken enough insulin. Other causes of high blood sugar include illness and emotional stress. Large amounts of sugar in the urine and blood indicate hyperglycemia. The patient may also be very thirsty, urinate more often than usual, and feel nauseated. A physician should be consulted to treat high blood sugar.

b. **Ketoacidosis**. This is another name for diabetic coma, a condition which may go along with high blood sugar. The cause of the condition is an imbalance of insulin and blood sugar to so great a degree that ketones build up in the blood. Ketones in great amount in the blood are poisonous. A slow developing ketoacidosis (occurring over several hours or several days) can usually be controlled at the first signs of high blood sugar or ketones in the urine. (Consult a physician immediately for instructions.) Other symptoms the patient may experience in addition to high blood sugar and ketones in the urine include dry mouth, great thirst, loss of appetite, excessive urination, dry and flushed skin, labored breathing, and fruity smelling breath. Less common symptoms which are sometimes present include vomiting, abdominal pain, and unconsciousness. Type I diabetics (insulin-dependent) are most likely to develop ketoacidosis.

3-10. OTHER HEALTH COMPLICATIONS FOR THE PATIENT

Diabetes mellitus is a complex metabolic disorder that can affect many parts of the body. Disturbances in other body parts may occur even before the usual symptoms of excessive thirst, too frequent urination, etc., appear.

a. **Vascular Disturbances**. There may be disturbances in the vessels of any part of the body. Most likely are problems in the nerves (diabetic neuropathy), the retina of the eye (diabetic retinopathy), kidneys, and the legs. The diabetic patient has a decreased blood supply to the tissues of the lower extremities (legs and feet) which increases the risk of problems in those areas. Any infection in the legs and feet must be attended to promptly; otherwise, ulcers may form and even gangrene leading to amputation.

b. **Visual Problems**. The retinal capillaries in diabetic patients have a tendency to develop multiple tiny bulges with small points of hemorrhage and exudates. The result is that scarring occurs in these capillaries from repeated hemorrhages. Presently treatment involves controlling the level of sugar in the blood and managing hypertension associated with the blood sugar level. The effect of laser therapy is being evaluated and researched also.

c. **Neuropathy**. Damage to nerve tissue is possible for the diabetic patient. The patient may experience facial paralysis or loss of muscle tone in the urinary system may result in diarrhea or constipation. A more common condition is problems in the legs. The patient may feel itching, numbness, tingling, and/or pain in the legs, a condition which is worse at night. There may also be a loss of sensation in the legs with the result that since the patient does not feel intense heat, for example, he can be burned without realizing it.

d. **Infection**. Infections heal slowly in diabetic patients. While the infection persists, diabetes becomes more severe. Skin lesions such as carbuncles and furuncles occur and are very slow to heal. If a diabetic patient has any skin eruption, he should contact his physician immediately.

3-11. CLOSING

Since the brain is so dependent on sugar, the patient with low blood sugar is in a life-threatening situation. Look for the signs and symptoms which spell impending doom and manage the situation early. Making a diagnosis is not critical, but appropriate interpretations of the patient's signs and symptoms are.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS. The following exercises are to be answered by writing the answer in the space provided. After you have completed all the exercises, turn to the solution at the end of the exercises and check your answers.

1. Diabetes is a disease that _____

   _____.

2. _____ (Type I) diabetes is the kind of diabetes in which the pancreas either does not make insulin or makes too little insulin for the body's needs.

3. List three factors that increase the risk of diabetes.

   a. _____.

   b. _____.

   c. _____.

4. In a person without diabetes, blood carries glucose to cells throughout the body, and insulin changes glucose into quick energy which _____ or stored for future energy needs.

5. In the digestive process of a diabetic patient, the normal process breaks down at the point where insulin should change glucose into quick energy or store the glucose. Instead, cells in the bloodstream cannot use glucose to make energy, and glucose _____ resulting in _____.

6. _____ diabetes usually affects people who are over 40 and overweight.

7. Hard-to-heal skin infections, blurred vision, tingling or numbness in the hands or feet, and gum infections which clear up slowly are signs/symptoms of _____ _____ diabetes.

8. How does obesity increase the risk of diabetes? _____ _____

9. The Tes-tape test in a urine test. If glucose is present in the urine, tape dipped into the urine will turn _____ or _____.

10. For the _____ test, the patient fasts for eight hours after which a blood sample and a urine specimen are taken. The patient drinks an oral glucose solution after which blood is drawn at 30 minutes, 1 hour, 2 hours, and 3 hours.

11. The goal in treating diabetes mellitus patients is to _____ _____.

12. Excessive amounts of ketone acids in the body is called _____.

13. A diabetic patient who takes insulin but does not eat enough food may develop _____, also called _____ shock.

14. A proper diet for the diabetic patient will have a balance of:

    a. _____.

    b. _____.

    c. _____.

    d. _____.

15. List two reasons exercise is of vital importance for the diabetic patient.

    a. _____.

    b. _____.

16. List four signs/symptoms of insulin shock.

    a. _____.

    b. _____.

    c. _____.

    d. _____.

17. _____ is the result when the diabetic patient's insulin and blood sugar become imbalanced to such a degree that ketones (poisonous in abundance) build up in the blood.

18. A diabetic patient may burn his leg because he has lost sensation to heat in his leg, a condition termed _____.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. Affects the way the body uses food and causes sugar levels in the blood to be too high. (para 3-1).

2. Insulin-dependent. (para 3-3a)

3. You are correct if you listed any three of the following:

   Heredity.
   Obesity.
   Women who have large babies.
   Women who have many babies
   Pancreatic injury, disease, or tumor.
   Emotional stress.
   A major disease. (para 3-2)

4. Can be used by the cells immediately. (para 3-1b)

5. Accumulates in the blood.
   High blood sugar levels. (para 3-1c)

6. Noninsulin-dependent. (para 3-3b)

7. Noninsulin-dependent. (para 3-4b)

8. Too much fat keeps insulin from being used properly by the body. (para 3-5).

9. Green.
   Blue. (para 3-6a(1)(a))

10. Oral glucose tolerance test. (para 3-6b(3))

11. Keep the patient's blood sugar level in the normal range. (para 3-7)

12. Ketoacidosis. (para 3-7c)

13. Hyperinsulinism.
    Insulin. (para 3-7c)

14. Calories.
    Carbohydrates.
    Fats.
    Proteins. (para 3-7c(1))

15. Exercise improves circulation.
Exercise helps the body metabolize carbohydrates. (para 3-7f)

16. You are correct if you listed any four of the following:

Hypoglycemia.
Sweating and pale skin.
Hunger.
Irritability.
Dizziness.
Headache.
Tremors.
Palpitations and tachycardia.
Lethargy.
Seizures.
Coma. (para 3-8b)

17. Ketoacidosis (diabetic coma). (para 3-9b)

18. Diabetic neuropathy. (para 3-10c)

End of Lesson 3